January 1998

The Effect of Protein Intake on Growth Performance, Plasma Urea Concentration, Liver Weight, and Arginase Activity of Finishing Barrows and Gilts

Hsin-Yi Chen
University of Nebraska-Lincoln

Phillip S. Miller
University of Nebraska-Lincoln, pmiller1@unl.edu

Austin Lewis
University of Nebraska-Lincoln, alewis2@unl.edu

The Effect of Protein Intake on Growth Performance, Plasma Urea Concentration, Liver Weight, and Arginase Activity of Finishing Barrows and Gilts

Hsin-Yi Chen
Phillip S. Miller
Austin J. Lewis[1]

Summary and Implications

An experiment was conducted to evaluate the effects of dietary protein concentration on growth performance, plasma urea concentration, liver weight and liver arginase activity of finishing (138 lb) barrows and gilts. Average daily feed intake, arginase activity and plasma urea concentration were greater in barrows than in gilts, whereas liver weight was lighter in barrows than in gilts. These data suggest gilts are affected more negatively by high protein diets than barrows. We believe the changes in liver weight and urea cycle enzymes (arginase) are related to these feed intake differences.

Introduction

The 1996 Nebraska Swine Report documented a study indicating that feeding high-protein diets to finishing barrows and gilts reduced feed intake, especially in gilts. We also observed that plasma urea concentration was greater in barrows than in gilts and suggested the response of plasma urea was attributed to greater feed intake in barrows. However, the liver, the organ responsible for the majority of amino acid degradation, weighed slightly less in barrows compared to gilts. One of the possible explanations for gilts' reduced feed intake is that the activity of urea cycle enzymes is inadequate to convert the ammonia produced from high-protein diets to urea. To prevent accumulation of toxic concentrations of ammonia, then, gilts may reduce their feed intake. To test this hypothesis, the following experiment was conducted to evaluate the effect of dietary protein concentration on the activity of liver arginase, one of five enzymes in the urea cycle, in barrows and gilts.

Procedures

Thirty-six pigs (18 barrows and 18 gilts) with an initial body weight of 138 lb were allotted to a randomized complete block experiment with a 2 × 2 factorial arrangement of treatments; two sexes (barrow and gilt) and two protein levels (16 and 25 percent CP). Diets (Table 1) were corn-soybean meal-based, fortified with vitamins and minerals to meet or exceed the National Research Council requirements for 110- to 240-pound pigs. Two crude protein concentrations were obtained by changing the ratio of corn to soybean meal.

Table 1. Composition of diets, as fed basis

	Dietary protein, %	
Item	16	25
Ingredient, %		
Corn	77.25	54.10
Soybean meal, 46.5% CP	20.35	43.90
Dicalcium phosphate	.85	.35
Limestone	.45	.55
Salt	.30	.30
Trace mineral premix	.10	.10
Vitamin premix	.70	.70
Analyzed composition		
Dry matter, %	89.38	89.87
Crude protein, %	16.04	24.99
Lysine, %[a]	.81	1.46
Calcium, %	.61	.64
Phosphorus, %	.46	.49

[a]Calculated composition.

Pigs were housed individually in an environmentally regulated facility and had *ad libitum* access to feed and water throughout the experiment. Pigs were weighed, feed intakes measured, and blood samples obtained weekly to determine average daily gain (ADG), average daily feed intake (ADFI), the feed efficiency (ADFI/ADG) and plasma urea concentration. The experiment was terminated when the average body weight of pigs reached approximately 230 lb. Pigs were allowed access to feed until four to six hours before slaughter. Livers were separated and weighed

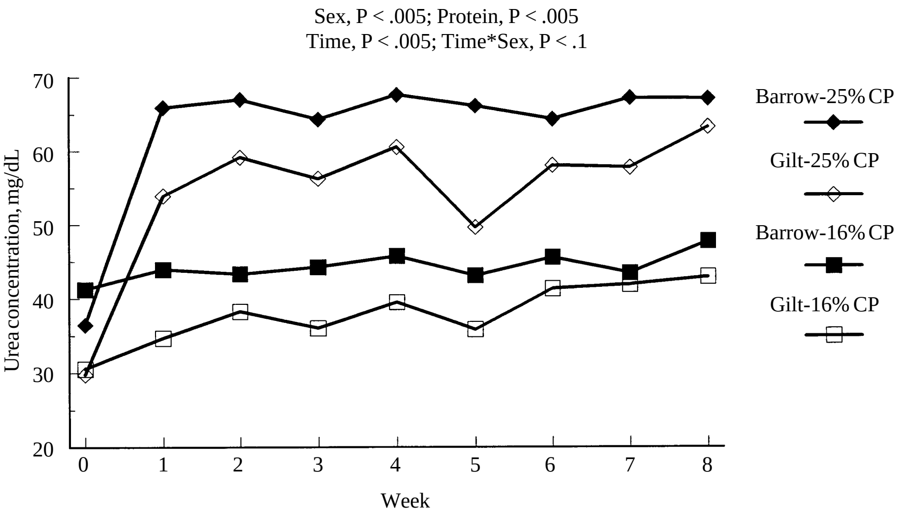

Figure 1. Plasma urea concentrations of barrows and gilts.

and liver samples were taken approximately 30 minutes after slaughter. Liver samples were frozen immediately in liquid nitrogen and kept at -80°C until analyzed for arginase activity. The unit of arginase activity was expressed as micromoles of urea formed per 30 minutes at 37°C.

Results and Discussion

Growth Performance

Average daily gain, average feed intake and feed efficiency are presented in Table 2. Because of illness, two pigs were withdrawn from this experiment. Average daily gain was reduced by 18 percent in gilts when dietary protein was increased from 16 to 25 percent, but was only slightly reduced in barrows. This resulted in a sex × protein interaction (P < .1). Average daily feed intake was greater (P < .1) in barrows than in gilts. Although feed intake was not affected (P >.1) by dietary protein concentration, it was 5 percent lower in gilts fed the 25 percent CP diet than those fed 16 percent CP. Feed efficiency was poorer in barrows than in gilts (P < .1). In addition, increasing dietary protein concentration resulted in poorer feed efficiency (P < .1). The growth performance results from this experiment were somewhat different from those reported in the 1996 Nebraska Swine Report, where the high-protein diet reduced weight gain by 10 percent and feed intake by 14 percent in gilts. The differences between the two experiments may be due to the differences in genetic background of pigs used (medium-high in the previous experiment versus medium-low lean growth potential in this experiment) and initial weight of pigs (112 versus 138 lb).

Liver Weight, Arginase Activity and Plasma Urea Concentration

Data for liver weight and arginase activity are summarized in Table 2. Data for plasma urea concentration are presented in Figure 1. No significant interactions (P > .1) between sex and protein concentration were observed. Barrows had lighter (P < .05) liver weights and greater (P < .05) arginase activities and plasma urea concentrations than gilts. Increasing the dietary protein concentration from 16 percent to 25 percent resulted in increased liver weight, arginase activity and plasma urea concentration (P < .005). The response of liver weight and plasma urea concentration to sex and dietary protein concentration in this experiment were similar to the results shown previously. Although gilts had less arginase activity per gram of liver than barrows, this difference was partially compensated by the greater liver weight of gilts. However, it remains clear that gilts are affected more negatively by high-protein diets than barrows and that gilts have lower plasma urea concentrations. These data indicate feed intake of barrows and gilts may be related to liver metabolic capacity and activity of urea cycle enzymes.

[1]Hsin-Yi Chen is a research technician and a graduate student, Phillip S. Miller is an associate professor, and Austin J. Lewis is a professor in the Department of Animal Science.

Table 2. Effect of sex and dietary protein on performance and liver arginase activity

	Sex	Barrow		Gilt	
Item	CP, %	16	25	16	25
No. of pigs		9	8	8	9
ADG, lb[a]		1.76	1.71	1.95	1.59
ADFI, lb[b]		7.15	7.05	6.79	6.42
ADFI/ADG[cd]		4.10	4.16	3.50	4.07
Liver, g[cef]		1,408	1,664	1,593	1,859
Arginase activity, µmol urea/g liver/30 min[ce]		12,313	16,370	11,624	13,458

[a]Interaction effect of sex x protein (P < .1).
[b]Main effect of sex (P < .1).
[c]Main effect of sex (P < .05).
[d]Main effect of protein (P < .1).
[e]Main effect of protein (P < .005).
[f]Warm carcass weight was used as a covariate in the statistical analysis.